Turbulence Prediction and Warning Systems

Weather Accident Prevention Project Review 2005

Williamsburg, VA

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Goals & Objectives

- **Weather Accident Prevention Goal:** Develop enabling technologies to reduce weather-related accident causal factors by 50% and turbulence-related injuries by 50% by year 2007.

- **WxAP Objective Number 3:** Develop en-route turbulence hazard prediction and warning technologies for reducing injuries to passengers and crew.

- **TPAWS Goal:** *Develop and augment knowledge of both the turbulence phenomena and the effects of turbulence on aircraft, and develop technologies to detect convective and clear air turbulence and mitigate the effects on aircraft passengers*

- Turbulence is the predominant weather threat for airborne tactical decision making relating to safety of cabin passengers and crew; also has significant operational costs impact

TPAWS Turbulence Hazard Synopsis

- **Accidents/Injuries**
  - All aviation accidents are being perceived as random events
  - Leading cause of injuries to passengers and crew/flight attendants
- **Operational Cost**
  - Analyses by Volpe estimates the turbulence related/induced TOTAL operational costs to US airlines at about $750M/year
- **Oversight Organizations**
  - CAST, NRC, IIR, OFCM have all advocated for and endorsed the TPAWS research activities to date, and the need for long term airborne turbulence safety research
- **Airlines**
  - Major airlines have initiated specific activities for turbulence injury and operational cost reduction objectives
  - Performance objectives relating to flight safety, operations routing and aircraft inspections, and overall customer satisfaction

TPAWS Priority Areas

- **Systems-Oriented Process**
  - Get the right turbulence information to/from the right aircraft with sufficient time for necessary decision making; focus on airborne tactical decisions
- **Enhanced Turbulence Radar**
  - Utilization of existing PWS hardware/architecture
  - Aircraft response hazard metric
  - Validated technology with LaRC 757
  - In Service Evaluation of single unit on revenue aircraft, with significant in-kind resource sharing
- **Certification Methods & Tools**
  - Turbulence Modeling and Simulation
  - Certification of Turbulence Airborne Radar via simulation
  - Collaboration with FAA for certification performance criteria

TPAWS Priority Areas

- **Turbulence AutoPIREP System**
  - Automated reporting of aircraft turbulence encounters, same hazard metric as E-Turb Radar
  - Aircraft-to-ground technology validation with LaRC 757
  - In Service Evaluation on diverse fleet of revenue aircraft
  - Integration into flight operations, inspection & maintenance
- **Turbulence Cockpit Displays**
  - Systems analyses, concept developments
  - Joint AWIN TPAWS simulation experiment planned, but cancelled due to resource and schedule conflicts
- **End User/Customer Collaboration**
  - WxAP Project Reviews
  - NASA-FAA-Industry Certification Workshops
  - TPAWS website for dissemination of technology status/flight results
  - Significant in-kind resource sharing/partnering

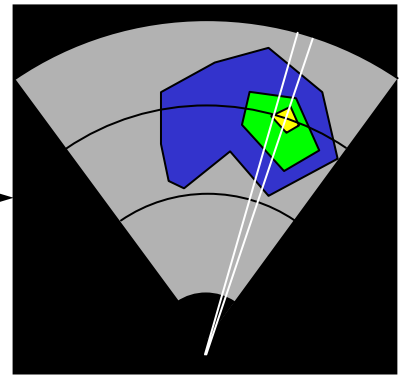
TPAWS Airborne Centric Concept

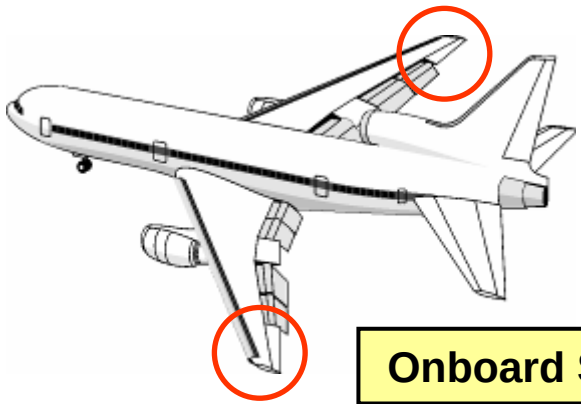
Weather Accident Prevention Project *Turbulence Prediction and Warning Systems*

Flight Management System A/C Controls/Mitigation Schemes

Decision Aids

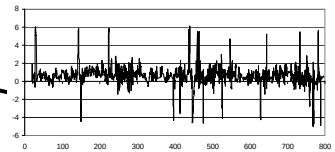
Presentation to Pilot





Processors

Onboard Sensors



Turbulence Auto-PIREP

Airborne Turbulence Information

Airborne scaling & display of Turbulence Auto-Pirep's information

Data Link

Data Link

Ground-based Turbulence Products

Forward-Looking Sensors: Radar and LIDAR

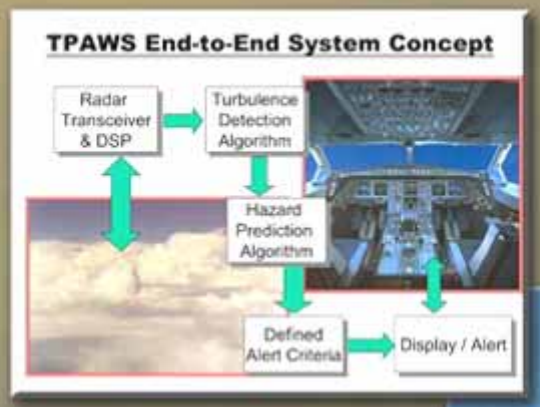
NASA TGIR *Revolutionize Aviation* Award

Weather Accident Prevention Project ***Turbulence Prediction and Warning Systems***

Aviation Safety Turbulence Prediction and Warning Systems (TPAWS) Team

Team Members: NASA Langley Research Center, NASA Glenn Research Center, NASA Dryden Flight Research Center, Federal Aviation Administration, AeroTech Research (USA), Research Triangle Institute, National Center for Atmospheric Research, North Carolina State University, Aviation Cabin Safety Specialists Incoporated

NASA and its partners are developing advanced airborne systems to predict and provide cockpit alerting for inflight turbulence-- the leading cause of injuries in airline incidents. These innovative technologies greatly enhance the capabilities of existing windshear radars and have been successfully flight-tested aboard the NASA 757 research aircraft. Results indicate important advancements to predicting turbulence ahead of aircraft that adversely affect scheduled commercial operations. This early warning will allow pilots enough time to advise flight attendants and passengers to buckle up resulting in significantly reduced turbulence-related injuries.



TGIR 2003
Williamsburg, VA

Goal One

TPAWS Research-Development Team

Weather Accident Prevention Project *Turbulence Prediction and Warning Systems*